Agency & Autonomy: Intersections of Artificial Intelligence and Creative Practice

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Abstract

Arguably, the most important aspects underpinning artistic experimentations in the broad fields of artificial intelligence (AI) and artificial life (A-life) lie at the intersection of autonomy and agency. **Autonomy** is the foundational element of any living system. Defined as the property of being self-determining with no outside control over actions and internal states, autonomy refers to a system's ability to assert its existence and to simply *be*. Through their interactions with their environment, autonomous systems achieve what noted biologist, neuroscientist and philosopher Francisco Varela called the "shap[ing of] a world into significance" [1]. This notion of autonomy as being assertive, ties right into the notion of **agency**. Defined as the ability to take action in the world and influence others, agency is how autonomy is exercised, articulated and maintained, via capacities such as adaptability, viability and sentience. With this in mind, this panel will bring together practicing artists and researchers who will discuss their work through the lens of agency and autonomy. How are AI-based tools and methods such as machine learning/deep learning, evolutionary computing and agent-based approaches currently being utilized by artists? The panel participants will discuss their work and individual approaches to these topics, followed by discussion.

Keywords

Artificial intelligence, machine learning, computational arts, autonomous systems, agency, robotics.

Introduction

Artificial intelligence (AI) and machine learning (ML) technologies have evolved alongside the development of computational systems. Research into computation machines and systems during the years surrounding the second world war had long lasting effects on various fields, and in this initial stage and later, the comparison of computation to the nervous system was being mapped out [2]. At the same time, computation machines developed alongside advancements being made in AI and ML. There have been some slowdowns and obstacles in AI research fields, but research developing AI has been around for decades and arguably perhaps centuries [3]. Recently due to more and more powerful computing capabilities complimented with large amounts of data exhaust, the more contemporary branch of AI has seen an explosion of sophistication in new applications of machine learning, and these technologies are now readily available to researchers, industry, and governments. It seems data has become embedded into every aspect of our lives, and AI is being explored for all kinds of applications and tasks. This explosion of AI and ML has also nudged its way into the discussion around creativity and artistic practice. The creative act is a complex and unique feature of subjective human intelligence. So perhaps this is one reason why creativity has become a target for engineers to set their sights on as a means to develop more sophisticated AI technologies.

In addition, these technologies are being explored by artists and the creative coding community. This raises many questions that this panel will discuss through their research and practice. Mainly, how is AI being applied in various creative practices, and how do familiar questions surrounding agency, authorship, and autonomy in the arts resurface through this new lens of AI. Furthermore, what does it mean that artists and engineers are experimenting with AI tasks that are creative in nature. This leads us to the question centered in this year's symposium – Why Sentience and other questions and topics to be discussed that include (but are not limited to): How are artists thematizing agency and autonomy in their work? How are AI-based tools and methods such as machine learning/deep learning, evolutionary computing and agent-based approaches currently being utilized by artists? What kinds of novel experiences are possible at the intersection of machine agencies and those of non-human organisms? What theoretical frameworks and methodologies can be utilized to properly analyze and evaluate this work? What are the politics of agency and autonomy in AI? The following subsections highlight the diverse ideas and practices of the panelists and each addresses these issues through research, arts practice, and industry experience.

Agencies of Deep Learning Generative Models in Creative Practice

In the last five years, there have been rapid advances in the machine learning branch of artificial intelligence. Specifically, a more powerful machine learning system has moved forward significantly – the type of deep learning called generative modeling. This machine learning model is distinct from its counterpart discriminatory modeling, in that this technology doesn't stop at just being able to classify data belonging to certain labels. Generative modeling has to infer patterns and structures in the data in order to be able to generate or create novel outputs [4]. It is truly a creative AI, and this raises very important ethical issues. In a time when data and information is constantly and simultaneously weaponized or under attack, the prospect of generative modeling raises issues between what data is accurate and what is generated by AI. At the same time, this new technology offers us a unique ability to really question and probe ML and AI itself. Because of how generative modeling must function in order to complete its tasks, it offers a lens into really understanding where the data comes from, how AI works to understand it, and what is the inherent structure of the data.

Figure 1. An image generated by the DeepDream model [5]. Images created and shared on Google Photos by Michael Tyka.

Five years ago, Google published a story about a technique they were developing called "Inceptionism" where the engineers were trying to understand "…what exactly goes on at each layer [within a Neural Network]" [5]. Specifically, the idea is to understand what is really going on with each layer in NN, why and how it works, and what are the properties that drive a model to be a success or a failure. As they were taking this closer look, the engineers came to "one surprise: neural networks that were trained to discriminate between different kinds of images have quite a bit of the information needed to *generate* images too." [6] The model was aptly named DeepDream, and by looking at the properties of the images, one can see the mathematical logic behind their creation: a mash-up of repeating, self-similar, and modular forms. What are the ramifications of a machine or AI as creative agent? The idea of what is an artist and what does it mean to be creative has a long history and has been debated throughout our history of culture and art. One could argue that this idea of machine as artist is simply another extension of this ongoing debate surrounding the artist or author. Rather than these questions, I propose that the more relevant questions are those surrounding how best to leverage these technologies within the creative act and how do these technologies inform our perceptions of the world and understanding of cognition.

While considering biological and technical systems, I will present research and works created through generative deep learning that highlight these issues. N. Katherine Hayles begins to pull apart some of these questions regarding AI, cognition, agency, and autonomy. She discusses 'nonconscious cognition' within biological and computational systems: "Notwithstanding the profound differences in contexts, nonconscious cognitions in biological organisms and technical systems share certain *structural* and *functional* similarities, specifically in building up layers of interactions from low-level choices, and consequently very simple cognitions, to higher cognitions and interpretations." Furthermore, Hayles points out the need to clear away questions regarding thought and cognition (both natural and technical), and "Following from these fundamental questions are further issues regarding the nature of agencies that computational and biological media possess, especially compared with material processes, and the ethical implications when technical cognitive systems act as autonomous actors in cognitive assemblages" [7]. Here Hayles is rightly clearing the ground. The questions about whether machines can think or whether machines can make art are irrelevant. Rather, they lead us to more relevant questions about agency in nonconscious cognition and the ethical implications when nonconscious cognitive systems act autonomously on our behalf. What are the properties of creative agency? What are those of autonomous agency? As Hayles is alluding to above by using such a concept as 'nonconscious cognition,' when we think about intelligent agency, and look at the functioning of natural systems, the answer to this question has become more elusive. Creative expression has been used throughout our history to tell stories and which functions an underlying aspect of our sentience. How do these creative neural networks or machine artists represent, question, undermine, or highlight this unique function of human autonomy, agency, and perception? What are the ethical, moral, and responsible developments of this technology?

Intersections of Living and Machine Agencies in the Arts

Since the 1950s, a multitude of artists have created artworks using and/or inspired by computational technologies. For this panel I will be discussing artworks that feature linkages between computational systems and non-human living organisms. The last several years has seen an increasing interest in this area of electronic arts. Although sometimes falling under the umbrella of biological art, I want to argue for its distinction as a unique genre, falling somewhere in between bio-art and computation art: what might be called biocybernetic arts. For this panel I will be focusing on a particular subset of this area: works that feature encounters or interactions between living organisms and intelligent — often agent-based — computational systems employing machine learning methods. Often these systems — like their living, non-human counterparts — are autonomous, that is, capable of taking action within their environment in response to what they sense and perceive. Here the autonomous agents respond to actions and behaviors of living organisms and produce some sort of output related to its learnings and interpretations of those actions and behaviors. Often, this output (in classic cybernetic fashion) is fed back into the living organism's environment, influencing its behavior in some way.

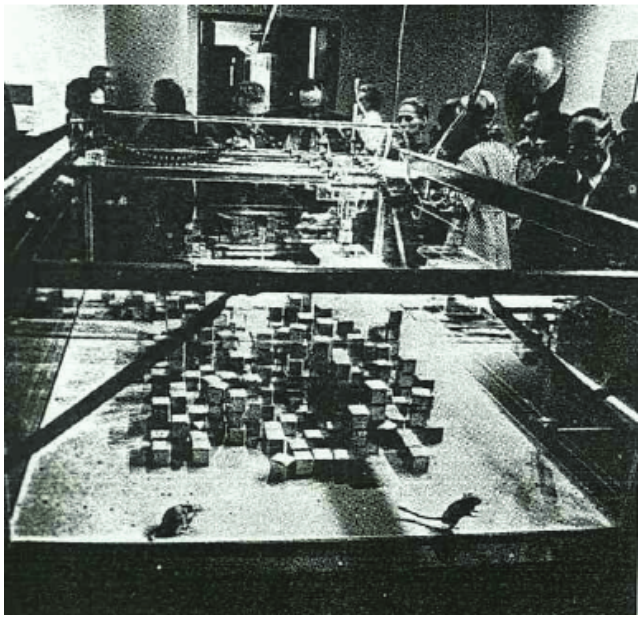

Figure 2. Gerbil Architecture (1970) by Nicholas Negroponte and cyberneticist Gordon Pask [5]. A small chamber of cubes is inhabited by a family of gerbils, who push the cubes around as they move throughout the space. A computer scans the scene at intervals and aligns them to a grid, either back to their previous position or at a new location in the grid.

Examining the social-cultural, technical and phenomenological implications that arise from these encounters between living and machine agencies, I will argue for the recognition of a distinct aesthetic paradigm rooted in the unique ways that non-human organisms and adaptive intelligent machines evolve their behaviors in response to one another. Building upon Peter Cariani's categorizations of adaptive and emergent systems [8] and Andrew Pickering's "non-modern" ontology of cybernetics and new media art [9], and drawing upon Francisco Varela's notions of the autonomy of the living [10], I will sketch out a provisional analytical framework to aid in understanding the meanings and implications of these works — works which through their explorations of novel forms of nature-machine interactions may be able to enhance our capacities for reimagining fundamental notions of evolution, intelligence and learning and facilitate new modes of approaching and understanding our techno-organic environment, opening up discussions on how both humans and non-humans are adapting and (co)evolving in response to the myriad of techno-scientific reconfigurations of their environment. Through the exploration of novel forms of nature-machine interactions, biocybernetic artworks we may be able to enhance our capacities for reimagining fundamental notions of evolution, intelligence and learning, to facilitate new modes of approaching and understanding our techno-organic environment and to open up discussions on how both humans and non-humans are adapting and (co)evolving in response to the myriad of techno-scientific reconfigurations of their environment. Furthermore, I will argue that by creating these strange types of techno-ecological systems that can bridge heterogenous life-worlds, all kinds of heretofore unimagined possibilities for mutual understanding and influence emerge, which may give us new perspectives on non-human alterities and may serve to question the anthropocentric the divisions between humans, human technology and the more than human world.

Sentient Beings: Responsible Human Agents and Creative Machines

A general AI that would fix all our problems or would destroy all our lives does not exist. The current proliferation of AI technologies using Machine Learning (ML) methods may come from the fact that each algorithm is developed for a specific task and situation. This is the diversity that makes this field collectively powerful. However there is a steep learning curve to understanding each of these algorithms. To properly apply them as a user, to co-create with them as an artist working with ML methods, or to appropriately bring these algorithms into our lives as a member of our society, the role of humans to ask questions and seek sensible actions in every step of artificial intelligence (AI) development and consumption has become vastly important.

Human Agents and Machinic Surrogates

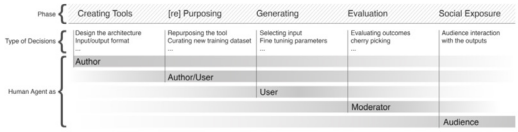

Figure 3. The Range of Human Roles in Collaboration with Machinic Surrogates [11]

The human roles in co-creation with ML algorithms range between the role of the author and the audience. In-between, there are positions as the user and as the moderator based on the tasks they undertake. Artists as human agents may engage in one or multiple phases throughout this spectrum. Using the definition of collaboration in 20th century art practice, the current relationship between human artists and ML algorithms is considered to be mediated through technical artifacts such as algorithms and data and thus the collaboration happens between human agents and their machinic surrogates.

Human or Machine Creators

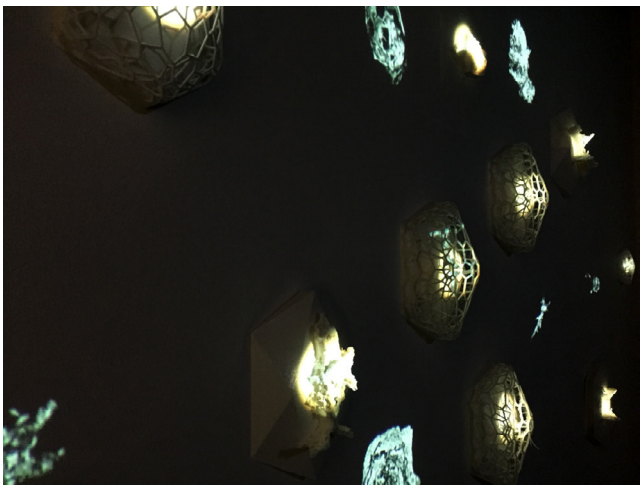

Figure 4. Installation View of the Aural Fauna Project [12]

Two examples will be discussed to look at the details of the relationship between humans and machines. First, the Aural Fauna project that is an interactive installation presented in 2019. Aural Fauna are unknown organisms imagined by AI. Human visitors may wake them up and share empathetic moments by touching or singing to them. The artist team of this project developed their own ML algorithms to imagine/generate the bodies of this unknown creature. The other example is a robot painting practice. The researchers of this project aim to make a creative robot artist that has its own artistic style and that is not merely a printer for reproducing processed or generated images.

Creativity in Question

How do we make a creative machine? Creativity is not a sudden burst out of blank space. It involves "a multitude of definitions, conceptualizations, domains, disciplines that bear on its study, empirical methods, and levels of analysis, as well as research orientations that are both basic and applied - and applied in varied contexts." [13] From Newell, Shaw, and Simon's insights on computational creativity [14] to Boden's definitions such as combinational creativity, exploratory creativity, and transformational creativity [15], defining what kind of creativity, which is appropriate for the specific task of a machine, would be a sensible first step to build a creative algorithm/machine. Yet some questions remain. Can we computationally model ambiguity? Would the novelty search result in a valuable discovery? Where is the threshold between randomness and creativity? Last but not least, how do we evaluate the creativity of an algorithm?

Sensible to Responsible

If we have a creative algorithm, it would need a dataset to learn from. As widely known, datasets raked to test ML algorithms may not accurately reflect our world. We are in the process of developing an online tool that collects people's face photos and labels. Participants may choose their way of contribution and provide accurate description of themselves from their own perspectives. This slow and self-defined method is presented as an alternative to the currently available image datasets and as a way to mitigate harmful biases in ML applications. As one of many steps we would need to take to be responsible human agents working with creative machines.

Performative Robots and Creative AI

This section discusses two performative robot projects that share a core ethos about the nature of human-centered AI (HC-AI) and Creative AI: *Amigóide* (2010-) and *Embodied Robots for Music* (2018). HC-AI focuses on the design, development and deployment of intelligent systems that cooperate with humans in real time in a deep and meaningful way. HC-AI is defined by two goals: (1) the AI system must continually improve by learning from humans while (2) creating an effective and fulfilling human-robot interaction experience.

The two projects apply these core goals as a central philosophy from which the concepts of Creative AI and Experimental Learning in the context of performative robots are developed. At the center of this discussion is the articulation of a shift in thinking of what constitutes Creative AI and new Human-Centered AI forms of machine learning

from inside the flow of shared experiences between robots and humans.

These projects explore new ways of working artistically with machine learning in real time, having the human artist in the loop with robots that sense constantly the environment and respond to it, challenging and enhancing human creativity by stimulating, inspiring, interacting and co-operating in the flow of embodied live improvise art-making, responding to the interaction with a human trough a cyclical relational process. Creative AI, in this view, includes practices that have AI embedded into the process of creation, but also encompasses novel AI approaches in the realization and experience of such work. The ultimate goal of these projects is not to find solutions to replace human creativity, but to enhance it and move it forward into new discoveries.

Amigóide: Engagement, AI, and Robotics

Amigóide (figure 5) is an automaton which searches for humans to engage in friendship with. Two versions have been developed, using different AI approaches. The first one (2010-2011) uses GOFAI (Good Old Fashioned Artificial Intelligence) [16], whereas version 2.0 (2019) was built utilizing a mix of GOFAI and deep learning, taking advantage of modern machine learning frameworks, which allowed the use of computer vision and image recognition techniques in real-time. The automaton interacts with people through movements, LEDs, synthetized voice and demonstrations of digital feelings. *Amigóide* reacts through its lights when the infrared sensor readings (version 1.0) or computer vision analysis of the camera video stream (version 2.0) indicate whether a human interactor gets close to it or not after a round of interaction.

Once the automaton finds a human it starts to follow this potential friend, intending to start an endless friendship. It gets closer to the eminent friend and poses the question: "Fabian, do you want to be my friend?". Fabian is an imaginary friend programmed into the automaton's mind. After the initial contact, *Amigóide* tries to conquer the friend through a series of sentences such as "Fabian, what do you look for in a friendship?".

Amigóide can be described as a rational agent, i.e., an agent "that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome" [17]. Hence, it is a rational agent whose best expected outcome is to establish contact with humans and conquer their friendship. The concept of rational agent is pivotal to this project because it leaves room for uncertainty. The aim of a rational agent is not to achieve perfect rationality – always doing the right thing, that in this case would be to do everything to acquire lifelong friendships –, as it is impossible in complex environments.

Figure 5. *Amigóide*. ©Fabrizio Augusto Poltronieri.

Embodied Robots for Music

The aim of this project is to investigate the technical solutions and artistic potential of AI driven robots co-creating with a human musician in realtime. The overarching research question with *Embodied Robots for Music* is: *If we want robots to join us inside the creative acts of music then how do we design and develop robot systems that prioritise the relationships that bind musicians inside the flow of music-making?* The goal of this research is to make humans more creative through deep and meaningful relationships with co-operating intelligent machines.

To solve the research question posed above, we needed to design, develop and deploy a robotic Creative AI that would have a presence within the co-creativity of the flow of *musicking* – the creative acts of realtime music-making. *Musicking* is a term that defines a perspective that 'to music is to take part' [18]. 'Taking part' can happen in any capacity such as performing, composing and listening. This approach reinforces the understanding that when musicians enter the world of *musicking*, there is coping in a very different world-of-concern than if they were walking down a street. In a sense they become a different creature with a different set of priorities and concerns than a normal, human wakefulness. The technical and artistic solution for *Embodied Robots for Music* focused on a robot that was first and foremost a coping entity in this specific world-of-concern.

Generative Systems for Music Composition and Production

The use of statistical processes and AI systems for the generation of music has a long history. In terms of the use of computer processing to aid music generation, early work beginning in the 1950s, notably includes that undertaken by Iannis Xenakis [19], John Cage and Lejaren Hiller [20, 21],

and later Charles Ames [22] and David Cope [23]. With the resurgence of neural network or connectionist systems in the 1990s [24], and most recently using network architectures termed deep learning, such sub-symbolic systems have shown good results in many generative application domains, including music composition and audio engineering.

Such systems have begun to reach performance levels which make them viable as commercial tools for musicians, and the wider public, to use. Music composition systems, aimed at enabling non-musicians to create musical pieces for video soundtracks, or as musical social network identities have been demonstrated by companies such as tomandandy.com and Humtap.com respectively. One of the authors (Smith), while employed at tomandandy.com, led the development of an experimental system "Ennio" in 2002 for matching music soundtracks to video sequences. This formed an early music information retrieval (MIR) recommendation system, matching the visual "rhythm" derived from peaks in a novelty measure between video frames to spectral features derived from the audio signal of recorded music using digital signal processing (DSP). In developing humtap.com in 2014, transcription of both melodic ("hums") and percussive ("taps") audio into symbolic representations is then used to drive a proprietary composition algorithm which seeks to combine the rhythmic structure of the tapping with the melodic contour of the humming. These musical fragments are recorded using internet connected smartphones by different users, so that the musical combination of pairs of users forms a musically oriented social interaction.

For music production, tools such as those from companies such Imagine Research (2010), iZotope.com (2012) and LANDR.com (2014) use AI methods to automate parts of the audio engineering required to produce professional sounding musical pieces. In the case of iZotope, several products used for audio restoration (noise reduction and repair) or signal processing are able to leverage such machine learning techniques as classification to identify regions of audio that exhibit problems. In the case of LANDR, classification is combined with model based learning to control audio signal processing to perform mastering (signal processing of mixed music tracks) automatically via a simple web interface. Other machine learning techniques such as recommendation, using audio features to search within a multidimensional space, are used by LANDR to suggest musical loops and samples (short audio fragments) which are acoustically musically similar, or complementary, to query samples.

There are common challenges which occur in producing such systems. These include issues around formulating design goals, such as the complexity of the user interface, based on the degree to which AI systems can understand musical goals of users and hence reduce the number of parameters a user must manipulate to achieve a goal. With improvement of machine learning model architectures, moving from rule systems informed by DSP in the case of Ennio, to linear classifiers such as support vector machines in systems by Imagine Research and iZotope, to non-linear systems such as deep learning in use at iZotope and LANDR, complexities of audio representation are able to be better learnt, when training on audio examples. However acquisition of training data which represents the musical task remains bounded by the problems of labelling, both in terms of requiring human annotation, and by differing ontologies of labelling for different musical genres or purposes. Such generated systems naturally pose questions of authorship and rights management, and the intersection of expectations of generated musical genres and how aesthetic judgements of generated music can be used in evaluating such systems.

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Authors' Biographies

Johnny DiBlasi is an artist who works with computational media, data and network hardware to create large-scale, interactive installations that fuse data into the physical architecture. With these works, he explores the aesthetic possibilities of data gathered by sensors dispersed throughout the landscape and how these artistic experiences can connect users to the pulse of the landscape in which they coexist. DiBlasi is Assistant Professor of Scientific Visualization and Digital Media in the Department of Art and Visual Culture at Iowa State University. DiBlasi earned an MFA from the Photographic and Electronic Media program at the Maryland Institute College of Art in Baltimore, MD. DiBlasi teaches studio courses in video, web design, creative coding and interactive media, and he exhibits his artworks and installations nationally and internationally.

Carlos Castellanos is an interdisciplinary artist and researcher with a wide array of interests such as cybernetics, ecology, embodiment, phenomenology, artificial intelligence and transdisciplinary collaboration. His work bridges science, technology, education and the arts, developing a network of creative interaction with living systems, the natural environment and emerging technologies. His artworks have been exhibited at local, national and international events such the International Symposium of Electronic Art (ISEA), SIGGRAPH & ZERO1 San Jose. Castellanos is Assistant Professor in the School of Interactive Games and Media at Rochester Institute of Technology.

Eunsu Kang is a Korean media artist making interactive art installations and performances. She is also a researcher on the possibility of creative AI and an educator teaching art-making using machine learning methods. Her career started as a self-taught video artist in Seoul, Korea. Having over 100 exhibitions and constantly studying new technologies for two decades, her works have transformed into interactive and interdisciplinary art projects. She has won the Korean National Grant for Arts three times. Her works have been invited to exhibitions around the world and presented at conferences such as ACM, ICMC, ISEA, SIGGRAPH Asia and NeurIPS. A couple of years ago she left her tenured art professorship to focus on research at the intersection of art and machine learning. Most recently she taught Art and Machine Learning and Creative AI courses at the Machine Learning department of Carnegie Mellon University.

Dr Poltronieri Fabrizio Poltronieri is an artist who explores the relationship between technology and deep-rooted philosophical concepts, such as chance. His current artwork involves Artificial Intelligence, applying machine and deep learning techniques to create and design narratives, moving images and objects. Poltronieri is an Associate Professor, member of the IOCT (Institute of Creative Technologies), and Co-Director of the Creative AI Research Group at De Montfort University, Leicester, UK.

Leigh M. Smith is a computer scientist, post-doctoral researcher and software developer of music information retrieval (MIR), audio signal processing, artificial intelligence (AI), computer graphics, and cryptography systems. He has worked on many commercial music software projects, and is currently a senior research engineer at LANDR Audio Inc. in Montreal, Quebec, where his focus is on automated mastering, music recommendation, and other music AI projects. He has previously worked with the Music Cognition Group at the Universiteit van Amsterdam and Analysis/Synthesis Group at IRCAM (Paris), and taught at several universities on music perception, cognition and MIR, with a focus on analysis and modelling of musical rhythm for interactive performance systems.